
Guías para generar la experiencia de cierre universitario (Curso Capstone)

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23 de agosto de 2010
Taller a la facultad del Recinto de Cayey

¿Quiénes somos?

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- PhD Ingeniería Eléctrica, Catedrático, Depto. Ing. Eléctrica y Computadoras
- Creador Curso Capstone en 2002
- Coordinador de Acreditación y Mejoramiento Continuo desde 2004



■ Nayda Santiago

- PhD Ing. Eléctrica /Computadoras, Catedrático Asociado, Depto. Ing. Eléctrica y Computadoras
- Dictando Capstone desde 2006



Tres fases del taller

- Parte I

- ¿Cómo es el capstone de ICOM?

- Parte II

- ¿Cuáles son algunas teorías/ideas sobre los capstone?

- Parte III

- Usted diseñará su capstone
 - Basado en las necesidades de UPR Cayey
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Objetivos del taller

- Apoyar a los profesores de UPR Cayey a manejar y desarrollar herramientas para la definición de un curso capstone.
 - Lograr que el profesorado defina los logros (outcomes) de un curso capstone en sus respectivas disciplinas.
 - Analizar si el aprendizaje basado en problemas/proyectos aplica como modelo para los cursos capstone en las diferentes disciplinas o proponer modelos alternos.
 - Evaluar diferentes alternativas de avalúo como posibles alternativas para los cursos capstone.
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¿Qué es un capstone?

- Definición en el diccionario
 - “the crowning achievement or final stroke; the culmination or acme”.
 - “A capstone course is one which will utilize all the knowledge gained from previous courses.”
 - ¿Qué piensa usted sobre como debe ser la experiencia de cierre universitario?
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Parte I: Caso de estudio

- El curso ICOM 5047
 - Capstone en ingeniería de computadoras
 - Nuestro curso
 - Aprobado por ABET
 - Evaluación con comentarios muy positivos
-

¿Qué dicen nuestros ex estudiantes?



Computer Engineer [CCE]

- Definition
 - Computer engineering is concerned with the design and construction of computers and computer-based systems.
 - It involves the study of hardware, software, communications, and the interaction among them.
 - Computer engineering students study the design of digital hardware systems including communications systems, computers, and devices that contain computers. They study software development, focusing on software for digital devices and their interfaces with users and other devices.
 - CE has a strong engineering flavor.
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ABET

- Accreditation Board for Engineering and Technology
 - Accreditation assures that a program has met quality standards set by the profession.
 - Changes in ABET
 - Continuous improvement, assessment
 - ABET's mandate: Major design experience
 - Solution: CAPSTONE
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ABET

- "Students must be prepared for engineering practice through a curriculum culminating in a major design experience based on the knowledge and skills acquired in earlier course work and incorporating appropriate engineering standards and multiple realistic constraints."
 - Quotation from ABET. Criteria for Accrediting Engineering Programs. Effective for Evaluations During the 2008-2009 Accreditation Cycle.
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What is Capstone Design?

- Apply the engineering sciences to the design of a system, component or process.
 - Students choose the particular design project with approval of appropriate faculty.
 - Computer Engineering
 - “The solution must involve the design and implementation of some product containing hardware and/or software components” [2].
-

What is Capstone Design?

- Apply the engineering sciences to the design of a system, component or process.
 - Students choose the particular design project with approval of appropriate faculty.
 - Computer Engineering
 - “The solution **must** involve the design **and** implementation of some product containing **hardware** and/or **software** components” [2].
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Hardware AND Software

- “The solution **must** involve the design **and** implementation of some product containing **hardware** and/or **software** components”
 - ABET requirement for the **UPRM CE** accreditation: **BOTH** Hardware **and** Software components
 - ABET requirement: no new concepts taught in **CAPSTONE**

Capstone Project

- Project
 - open-ended problems
 - development and use of design methodology, formulation of design problem statements and specification, consideration of alternative solutions
 - feasibility consideration
 - detailed system descriptions
 - realistic constraints
 - Economic factors, social impact, ethical, environmental, and others
-

Design Experience [2]

- The culminating design experience should provide students with a wealth of learning benefits. The benefits stemming from this experience include:
 - Demonstration of the ability to integrate concepts from several different subjects into a solution
 - Demonstration of the application of disciplines associated with computer engineering
 - Production of a well-written document detailing the design and the design experience
 - Demonstration of creativity and innovation
 - Development of time management and planning skills
 - Self-awareness opportunities provided by an assessment of achievement as part of a final report
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Moreover....

- Capstone faculty **MUST** demonstrate that all students in ICOM 5047 have attained all a-k ABET outcomes:
 - a. An ability to apply knowledge of mathematics, science, and engineering
 - b. An ability to design and conduct experiments, as well as to analyze and interpret data
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Moreover...

- c. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
 - d. An ability to function on multidisciplinary teams
 - e. An ability to identify, formulate, and solve engineering problems
 - f. An understanding of professional and ethical responsibility
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Moreover...

- g. An ability to communicate effectively
 - h. The broad education necessary to understand the impact of engineering solutions in a global and societal context
 - i. A recognition of the need for, and an ability to engage in lifelong learning
 - j. Knowledge of contemporary issues
 - k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
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Outcomes Capstone Course ICOM

| Course Outcome | Program Outcome |
|---|-----------------|
| Identify a problem or opportunity for a computer engineering solution or innovation and define the technical specifications with the user/client. | (e) |
| Analyze and discuss the problem as well as previous or related work | (a) |
| Write a project proposal to solve a computer engineering problem specifying the solution, the work breakdown structure, budget and realistic constraints. | (e) |
| Organize the teamwork and define individual tasks and responsibilities | (d) |

Outcomes Capstone Course ICOM

| Course Outcome | Program Outcome |
|---|-----------------|
| Design implement and test a system to solve the desired needs, identify and design the components within realistic constraints and using engineering standards | (c) |
| Design a test plan for the system | (b) |
| Evaluate the ethical, legal, environmental, social, health and safety and other impacts of the system and propose the mitigation, or compensation measures when necessary | (f) |
| Write effective documentation using engineering standards, present the results and make demonstrations of system functionality | (g) |

Outcomes Capstone Course ICOM

| Course Outcome | Program Outcome |
|--|-----------------|
| Use modern computer engineering tools for analysis of the problem, computer aided design, debugging, implementation and testing of the system. | (k) |
| Assess the final economical, environmental, legal and other aspects of the project in a post-mortem review | (h) |
| Make project decisions based on current literature and state-of-the-art tools available on campus, or provided by client/user when applicable | (i) |
| Assess Intellectual Property potential of the project and its implications in such issues as licensing, and marketing among others | (j) |
| Incorporate engineering standards and multiple realistic constraints | (c) |

What do we expect from students before they come to the course?

■ Knowledge

□ Hardware Design

- Architecture
- Programming firmware (micro I)
- Digital Electronics

□ Software Design

- ER, Use case diagrams, Class diagrams, test cases
- Design patterns

□ Soft skills

- Presentations, writing, working in teams, time management
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Seminars

- Project Management
 - Budget Writing
 - Proposals
 - Teamwork
 - Effective Meetings
 - Document and Info. Management
 - Patents
 - Conflict Management
 - Oral Communication
 - Creativity
 - Writing a Report
 - Environmental Impact
 - Ethics
 - Entrepreneurship
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Assessment

- “Happy Hours”
 - Homework
 - Presentations
 - Evaluation sheets
 - Reports and Documentation
 - Proposal
 - Reports
 - Technical Documentation
 - Code and Schematics
-

Happy Hours, Homeworks, Presentations

- “Happy Hour”
 - Defined by Dr. Noack – Oral exam, demonstration
 - Not happy, not an hour, more than one evaluator
 - Rubric is based on the project
 - Homework
 - Evaluate specific outcomes of the program
 - Example: Ethics, Environmental Impact
 - Presentations
 - Presentation skills, rubric
 - Example: Candela
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Ejemplo de hoja de evaluación

| Problem Statement | Score | 5 | 15% | Comments |
|---|-------|---|-----|----------|
| Clearly describes the problem to be solved by the product/service | | R | | |
| Identifies variables involved in the problem (qualitative or quantitative) | | R | | |
| Identifies project stakeholders | | R | | |
| States how the project provides a solution to the problem | | R | | |
| Presents the scope of the project based on the variables of the problem that can be feasibly addressed by the project | | R | | |

Ejemplo de hoja de evaluación

| SMART Objectives, Outcomes and Metrics | Score | 6 | 15% | Comments |
|--|-------|---|-----|----------|
| Objectives are specific | | R | | |
| Objectives are measurable (provide metrics to measure achievement for each objective) | | R | | |
| Objectives have been agreed upon with client (client must have been identified among the stakeholders) | | R | | |
| Objectives are realistic taking into account available skills, expertise and resources. | | R | | |
| Objectives can be achieved within the time assigned for the project taking into account available skills, expertise and resources. | | R | | |
| Provides detailed description of project's deliverables as related to objectives' achievement | | R | | |

Reports and Documentation

- Proposal
 - Project Management Plan
 - Resources Plan
 - Task assignment
 - Scope
 - Progress Report
 - Testing sheets, accountability
 - Final Report
 - Repository
-

Examples of past and current projects

Examples of past projects

- Scoreboard



Scoreboard

- **Hardware**

- Wireless connection between a score keeper box and computer
- Display

- **Software**

- Database
 - Web interface
 - Firmware
-

Scoreboard



RumStick



RumStick

■ Hardware

- ❑ Control sensors
- ❑ Sensor interface
- ❑ Gumstick
- ❑ Read data from sensors wirelessly

■ Software

- ❑ Drivers, RTOS
 - ❑ Interface to database
 - ❑ GUI
-

RumStick



RUMStick on Happy Hour day...



or night???

Capstone at the End



Lessons learned

- Groups who start early succeed.
 - Part of the project comes from Micro II and/or SE or DB.
 - Successful groups
 - Everyone contributes.
 - Diverse background and knowledge.
 - Respect each other (not necessarily friends).
 - Students are successful if they are responsible and willing to learn independently.
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Lessons learned

- Groups that start late have a very hard time.
 - No sleep, health problems.
 - One person can spoil a group.
 - Team players are needed.
 - If you did not learn what you were supposed to learn in five years, capstone becomes daunting....
 - Happy Hours become unhappy when you did not do what you were supposed to do.
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Past Problems with Capstone

- I took Analog Integrated Circuit Design but I want to design a microprocessor interface....
 - Take the appropriate prerequisites or design a project using the Analog IC you designed in the class....
 - I took databases and SE but did not learn how to design software.....
 - Everyone must know how to design software (fundamental skill).
 - Everybody in the group is software engineer....
 - Wrong. You are a CE.
 - I cannot agree with my partners....
 - Learn how to deal with difficult people. Life is not fair.
 - It is not my responsibility....
 - Yes. It is.
-

Not all is bad...



Proud students



Post course evaluation for ABET

- Fill Rubrics according to the program
 - Turn in all graded documents as evidence.
 - **ALL EVIDENCE!!!**

 - Example of rubric.
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Rubric for Outcome f: An understanding of professional and ethical responsibility

| | |
|---|---|
| 1 | Given an ethical problem, students can informally analyze the situation |
| 2 | Students are aware of applicable codes of ethics, such as those of CIAPR, IEEE or ACM. |
| 3 | Given an ethical problem, students can use applicable codes of ethics, such as those of CIAPR, IEEE or ACM in the analysis of the situation. |
| 4 | Given an ethical problem, students analyze the ethical situation using applicable codes of ethics and the formal ethical criteria (e.g., least harm, reversibility, and publicity). |
| 5 | Students can identify a compromising ethical situation, and analyze it using applicable codes of ethics and formal ethical criteria (e.g., least harm, reversibility, and publicity). |

Parte II

Cuáles son algunas teorías/ideas
sobre los capstone

¿ Como se diferencia un “Capstone” a una experiencia de cierre universitario?

■ Capstone

- Se prueban las destrezas aprendidas en el programa.
- Se utiliza para evaluar el programa y cada individuo.
- No se provee conocimiento nuevo al estudiante.

■ Experiencia de cierre universitario

- Experiencia en la industria? No necesariamente se evalúan las destrezas.
- Puede estar distribuido en varios cursos a lo largo del programa (Integración vertical)

Tomado de la pagina de ABET.

Elementos en el diseño de un curso

- CAP (Content, Assessment, Pedagogy)
 - Contenido
 - Avalúo
 - Método Pedagógico
- Ejercicio (Think-Pair-Share)*
 - Piense en un curso que quiera diseñar o re-diseñar.
 - Explique que usted interpreta por CAP
 - Basado en su mejor entendimiento, como se relacionarian el contenido, el avaluo y el metodo pedagogico?

*Tomado de Ruth A Streveler; Karl A. Smith; Rocío Chavela Guerra (2010), "CAP Session 1 – Content," <https://cleerhub.org/resources/52>.

CAP (Content, Assessment, Pedagogy)

■ Contenido

- Debe ser enseñado en los cursos del programa.
- ¿Cual es el contenido necesario para educación general?
 - Definido en el documento “Nuevo proyecto de educación general”.



CAP (Content, Assessment, Pedagogy)

- CAP

- Contenido

- **Avalúo**

- Método Pedagógico

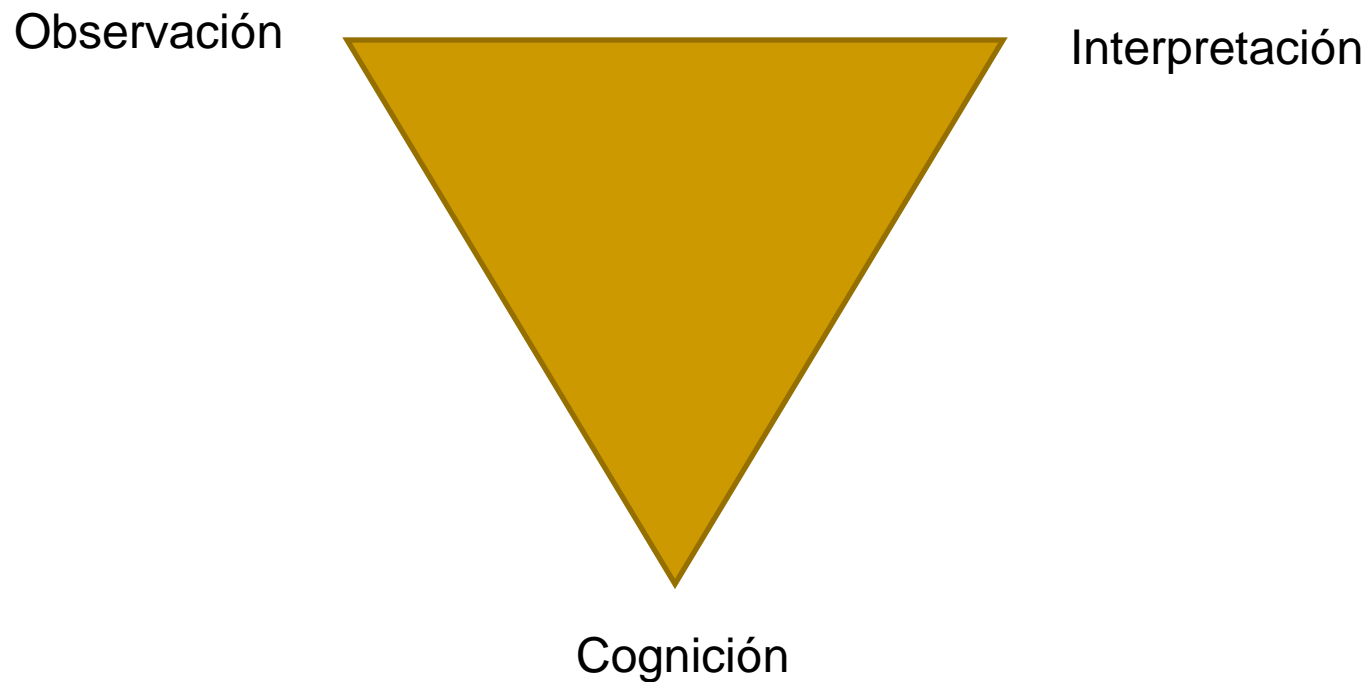


CAPSTONE

- AVALUO SUMATIVO
- Retroalimentacion al programa!!!!!!



Triángulo de Avalúo

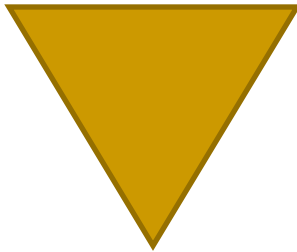


- Tomado de Pellegrino et. al. (2001)
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Pellegrino et al.

- “Every assessment, regardless of its purpose, rests on three pillars: a model of how students represent knowledge and develop competence in the subject domain, tasks or situations that allow one to observe student’s performance, and an interpretation method for drawing inferences from the performance evidence thus obtained.”

Observation



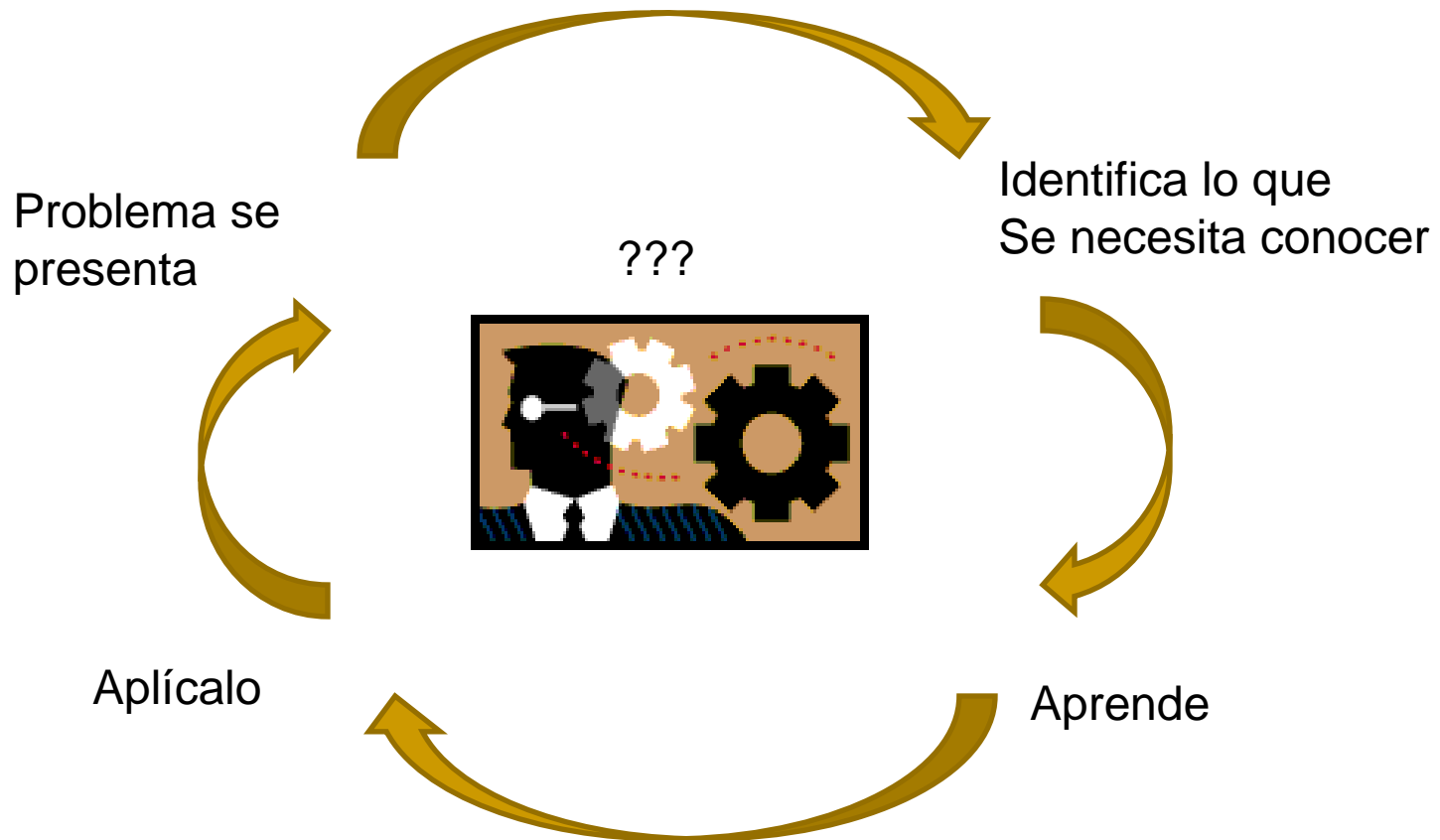
Interpretation

Cognition

CAP (Content, Assessment, Pedagogy)

- Método Pedagógico
 - Aprendizaje Activo
 - Aprendizaje Cooperativo
 - Aprendizaje Basado en Problemas
 - Aprendizaje Basado en Casos de Estudio
-

Aprendizaje basado en problemas



Tomado de Ruth A Streveler; Karl A. Smith; Rocío Chavela Guerra (2010), "CAP Session 3 - Pedagogy," <http://cleerhub.org/resources/56>.

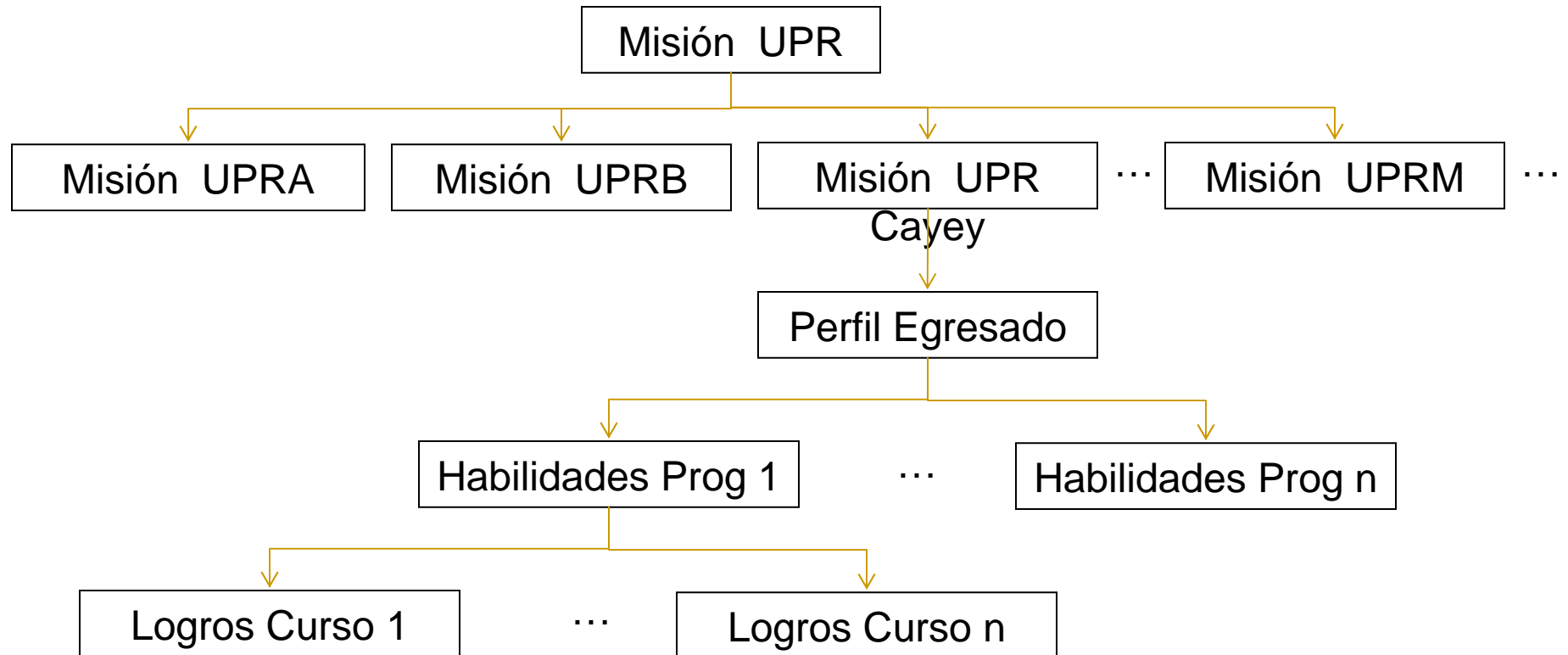
Noten

- Se decide el perfil del egresado (content)
 - Destrezas que debe poseer
 - Basado en algun criterio
 - Se trabaja para lograr esas destrezas (pedagogies)
 - Se avalua
 - Determinar si se lograron los objetivos y logros
 - Se retroalimenta
 - Corregir el programa, cursos, etc.
-

Parte II

Usted diseñará su capstone basado
en las necesidades de UPR Cayey

Coherencia entre Misión y Logros



Ejercicios

- Ejercicio 1: Identificaremos el mapeo de las habilidades del componente de educación general en el perfil del egresado de UPR – Cayey
 - Ejercicio 2: Llenar la tabla donde identificarán las metas de aprendizaje para su curso y las actividades pertinentes.
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Ejercicio 3

- **Habilidades y contenidos UPR Cayey**
 - **1. Comunicación efectiva:** capacidad para comunicarse en forma oral y escrita efectiva y crítica en español, en inglés, a través de las matemáticas, las artes, y si posible en francés, italiano y cualesquiera otros lenguajes que se cultiven en la institución.
 - Destrezas para:
 - la lectura de comprensión, analítica y crítica
 - la expresión escrita reflexiva y crítica
 - la expresión oral reflexiva y crítica
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-
- Conocimientos acerca de: la teoría de la comunicación
 - la semiótica
 - la lingüística
 - la teoría psicológico social
 - Actitudes de:
 - Receptividad
 - aprecio e interés por enriquecer los lenguajes pertinentes
 - tolerancia
 - trato justo
 - voluntad de claridad y coherencia
 - Dialogicidad
-

-
- Ejemplo de procesos-productos indicativos de la habilidad:
 - Interpretación o producción de comunicaciones orales y escritas, en torno a un asunto, tema o lectura, de carácter claro, coherente, pertinente, con vocabulario adecuado, sintaxis correcta y perspectiva crítica.
 - Nota: Al tomar en consideración al estudiante de Cayey y las experiencias habidas en la enseñanza del inglés, se podría considerar estudiar este idioma como si se tratara, metodológicamente, de una lengua extranjera.
 - Teoría general de los signos.
 - Ciencia que estudia, entre otros, el desarrollo y las características del lenguaje.
 - Dialogicidad: disposición para asumir la perspectiva de aquellos con quienes no estamos de acuerdo.
 - Con esta expresión se quiere aludir a que se pretende evaluar tanto el proceso como el producto de la habilidad. Por ejemplo, al redactar un texto se evalúa no sólo la versión final del mismo sino *que se debe proporcionar retroalimentación a través del proceso* (diagramas, bosquejos, primeras versiones previas, etc.).
 - En caso de comunicación oral, la misma sería filmada en vídeo para ser evaluada.
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Ejercicio

- Identifique como haría una rúbrica para evaluar esta habilidad en SU CURSO CAPSTONE
 - Basado en
 - Destrezas, conocimientos y actitudes asociada con esa actividad.
-

Comentarios finales

- Proceso continuo
 - No es fácil, una vez se identifica una falla del programa, arreglarlo
 - Resultados se ven con un retraso de tiempo
 - Nuestros estudiantes cambian, los tiempos cambian, las destrezas cambian
 - El perfil debe ser dinámico
 - Nunca hemos dictado un curso capstone que haya sido igual al semestre anterior – dinámico
 - Esperar lo inesperado
 - Facultad receptiva
-

Preguntas?

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